



Chapter 6

High School Technology

Education Model

Curriculum

MISSOURI TECHNOLOGY EDUCATION GUIDE
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High School Technology Education Model Curriculum

1. Introduction

This chapter contains the materials from the ITEA-CATTs Foundations of Technology Education Curriculum (ITEA 2001). This document was developed by and for the CATTs Consortium for use by its members. Missouri was a Consortium member during the year that this product was developed, giving Missouri the rights to utilize, copy and distribute this product to Missouri teachers. This high school guide contains over 100 pages. For that reason, only the first chapter of the Foundation for Technology Education is included in the printed version of the Missouri Technology Education Guide 2002. The complete text, with activities and photos, is included on the CDROM version.

2. Recommended High School Curriculum

This chapter provides the curriculum framework for one of the high school courses recommended in *A Guide to Develop Standards-Based Curriculum for K-12 Technology Education* (ITEA, 1999) for standards-based contemporary high school programs. These courses are:

- *Foundations of Technology*
This beginning high school course prepares students to understand and apply cornerstone technological concepts and processes. Group and individual activities engage students in creating ideas, developing innovations, and engineering practical solutions. Technology content, resources, and laboratory activities encourage student applications of science, mathematics, and other school subjects.
- *Technology Assessment*
Technology has positive and negative impacts, and intended and unintended results. In this course, students learn ways to evaluate the appropriateness and effectiveness of various technologies. Students engage in technology activities to determine and assess the effectiveness of new ideas, innovations, and technological systems. Analytical thinking, decision making, and continuous design improvements are emphasized.
- *Issues in Technology*
Students investigate critical historical and emerging issues affecting the creation, development, use, and control of technology. Case studies, simulations, portfolio developments, and group seminars are ways that students address complex issues and propose alternative solutions to technological developments. Global governmental, social, and economic policies concerning technology are studied.
- *Engineering Design Fundamentals*

Engineering scope, content, and professional practices are presented through practical applications. Students in engineering teams apply technology, science, and mathematics concepts and skills to solve engineering design problems and innovate designs. Students research, develop, test, and analyze engineering designs using criteria such as design effectiveness, public safety, human factors, and ethics.

The ITEA-CATTs Consortium provides additional resources to implement these suggested standards-based courses.

3. Foundations of Technology: Scope and Sequence

Introduction

High school is a period of preparation and application. Technology education at the high school level prepares students to understand, use, manage, and assess technology in order to be technologically literate. This course guide reflects essential knowledge and activities that students should experience in a standards-based technology education class. This chapter will describe important instructional considerations for teaching high school students about technology. In addition, this chapter will highlight instructional methods that go beyond traditional lecture, demonstration, and testing to allow students the opportunity to perform at higher levels and grow in their technological literacy. More detailed information on instructional methods for standards-based high school technology education courses can be found in *Teaching Technology: High School* (ITEA, 2000).

High School Curriculum Scope

Compared with the middle school student, the high school student has the opportunity to study technology in more detail and with more sophistication. At this level, students will engage in a wide range of instructional activities designed to build a detailed understanding of technology. Students who enter high school without prior learning in technological studies will need an orientation and introduction to the general concepts of technology and its study. The curriculum and instruction in eleventh and twelfth grades generally provide more depth in terms of content and laboratory/classroom experiences.

The breadth of the curriculum beginning at the ninth grade level is a matter of articulation between the middle school curriculum and the high school curriculum. Much effort should focus on the school system's ability to document students' achievement of the technological literacy standards throughout their school years. Such information is critical to the development of curriculum and instruction at the high school level. An introductory high school course for all students should be offered to help high school students learn about fundamental technological concepts. **Foundations of Technology** is recommended as this cornerstone course in the high school technology education curriculum. See *A Guide to Develop Standards-Based Curriculum for K-12 Technology Education* (ITEA, 1999).

Foundations of Technology prepares students to understand and apply cornerstone technological concepts and processes. Group and individual activities engage students in creating ideas, developing innovations, and engineering practical solutions. Technology content, resources, and laboratory/classroom activities encourage student applications of science, mathematics, and other school subjects in authentic situations. This course can be offered to students in grades 9 through 12 and to students with diverse abilities.

***This course can be offered as a half-year or full-year course. Students enrolled in a single semester course (half-year) will attain fewer of the standards specified than students who take two semesters of Foundations of Technology.*

In order for students to fully attain the technological literacy standards, the following high school courses also are recommended:

- *Technology Assessment*
Technology has positive and negative impacts, and intended and unintended results. In this course, students learn ways to evaluate the appropriateness and effectiveness of various technologies. Students engage in technology activities to determine and assess the effectiveness of new ideas, innovations, and technological systems. Analytical thinking, decision making, and continuous design improvements are emphasized.
- *Issues in Technology*
Students investigate critical historical and emerging issues affecting the creation, development, use, and control of technology. Case studies, simulations, portfolio developments, and group seminars are ways that students address complex issues and propose alternative solutions to technological developments. Global governmental, social, and economic policies concerning technology are studied.
- *Engineering Design Fundamentals*
Engineering scope, content, and professional practices are presented through practical applications. Students in engineering teams apply technology, science, and mathematics concepts and skills to solve engineering design problems and innovate designs. Students research, develop, test, and analyze engineering designs using criteria such as design effectiveness, public safety, human factors, and ethics.

Instructional Methods

Design is one method that is implemented in this model course. A wide range of people conduct design activities throughout the course of any given day. Teachers frequently design instructional activities based on the learning objectives their students are expected to achieve. Engineers, for example, design new products, processes, and solutions based on the design's requirements. They apply mathematics and scientific principles to the development of a design. Frequently, they will use mathematical and computer models that support the development process and predict the behavior of what is being created. Like most designers, engineers use iteration in the design process when they add an element to a design and then check the results against the requirements. Although the design processes used in various fields may be similar, a particular field may have unique standards and practices. For example, when production engineers design production tooling, they will apply a set of tooling design principles.

Portfolio development is recommended in several unit activities. Portfolios are not journal notebooks in which the authors write every thought or note. Student portfolios do not necessarily have to be as clean and pleasing as a portfolio a designer would use to show his or her best work. Student portfolios may be a combination of a design portfolio and a means of communicating their achievement, growth, and insights to the teacher, their parents, and even their future colleges and employers. The portfolio reflects student thinking and visualizing processes as well as design stages in the products and systems they produced in technology class.

Technological problem solving is a method of instruction that provides students the opportunity to apply, analyze, synthesize, and evaluate what was learned from previous experiences. Using this method allows students the opportunity to *discover* new knowledge, develop critical thinking skills, and manage their own learning. Additionally, it is a practical method for teaching very abstract concepts from other disciplines—science and mathematics, for example. Technological problem solving could include

opportunities for discovery, research and development, and the use of engineering design briefs. These methods should be planned to consciously address *STL*. While a comprehensive system of teaching technological problem solving is useful in any technological studies course, such a practice will prove especially important in *Foundations of Technology*.

One model for technological problem solving proceeds in three phases: the design phase, the construction phase, and the evaluation phase (LaPorte & Sanders, 1996). If teachers use this basic procedure when their students are *engineering* various technological solutions to problems, they may provide continuity for students in dealing with the problems that they will attempt throughout the school year. Detailed information for using the technological problem solving method can be found in *Teaching Technology: High School* (ITEA, 2001).

Discovery is the process of identifying new knowledge, insights, and realizations in the context of active modes of inquiry. An example of a discovery approach is when students apply the scientific method to discover something (learn something new) about the world.

When students do, in fact, have the freedom to explore learning beyond the explicitly taught content, they will learn additional concepts and skills with some guidance and structure. Students have to be active to accomplish this. Their teacher needs to allow them to “think out of the box.” Discovery is a major recommended outcome for technological studies.

Research and Development (R and D) provides a means for investigating technological content. The process of R and D is a recommended instructional method for high school students because they have the maturity and depth of knowledge in order to pursue specific areas of study related to the interests they have developed throughout their education. Research and development may be conducted in cooperative groups or as independent studies for individual students. For more information, see *Teaching Technology: High School* (ITEA, 2001).

Design briefs can be used to introduce or frame a problem. While design briefs may be highly structured and specific when they are used with a new class of students, they may provide less structure as students become more sophisticated. Students may even write their own design briefs. A difficult-to-machine product in a manufacturing production run is an example of a very specific problem with a narrow scope. While there may be more than one correct solution to the problem, the exercise provides an example of a teaching method for a specific type of content. On the other hand, an example of a broad problem might involve the lack of adequate housing in a community, and solving it may require the application of broad content.

These methods are described in detail in *Teaching Technology: High School* (ITEA, 2001). The teacher is encouraged to review this guide in preparation for implementing *Foundations of Technology*.

Assessing Students

Assessing students involves continuously monitoring student progress toward understanding technology content and developing abilities for a technological world. This guide provides guidance for assessing students in the unit sections labeled **acceptable evidence** and in each assessment section following the suggested learning activities. Assessing students using multiple approaches during and following teaching and learning activities is strongly encouraged. The following assessment approaches may be used to monitor student progress and achievements:

Performance assessment is perhaps the most authentic assessment method next to on-the-job

performance and ultimately prospering as a citizen. Because students need to learn design concepts, they should participate in designing real-life products, processes, and solutions. By watching students use a given technology, teachers can determine their proficiency at using and controlling it. This performance assessment method allows teachers to get around typical problems associated with written testing—validity and reliability, for example. Performance can be measured during an activity that is set in a real-life context or in a formal setting. It can also be used to measure all levels of learning in all three domains of learning discussed in Chapter 1. Performance measures should initially center on content (processes and products) specified in the standards and their related benchmarks.

Using rubrics will provide teachers with an inventory of desired behaviors and guide them in making judgments regarding student achievement within a range of mastery. After developing the objectives and activities for a unit, teachers should develop a listing of desired behaviors. The behaviors should be derived from the objectives, considering the context of the activity and using the objective criteria (Custer, 1996). Teachers should develop rubrics to use when assessing students' portfolios. Some considerations for developing criteria for portfolio assessment are outlined in *Teaching Technology: High School* (ITEA, 2001).

Self-assessment provides an alternative to written tests. Teachers should encourage their students to reflect on their own performance. For student self-assessment, teachers should ask individual students to compare perceptions of their own work to the guidelines and criteria that have been established. These criteria are those same elements that are identified by students as requirements. This process provides the teacher with an opportunity to “get inside” the student’s mind to assess things like creativity and metacognition. Self-assessment can be made a regular part of the student’s portfolio, and teachers can include a checklist component or rubric, as well as a written narrative component.

Group and peer assessments are valuable measures of student learning within groups. Students will frequently work in groups and may be afforded the opportunity to assess the achievement of their own groups. The criteria would focus on group dynamics, responsibility, organization, strategies, and presentations.

Physical Products/Projects: Teachers should develop rubrics or checklists to assess student projects. The criteria for the assessment may be determined, in part, by students when they set criteria for developing a solution to a design problem or challenge.

Student lab reports/ journals: Scientists and engineers are required to keep extensive notes on their daily progress on projects, not only to inform their company but to prove that the ideas were actually their own. Instructors should use the lab report as a tool to keep track of individual student progress. This practice links English writing skills with technology. The journal or lab report is also an important document when discussing a student’s progress with their parents. Lab reports or journals can cover one or two week’s worth of work at a time, and should be kept in the classroom (Gomez, 2001).

Essays are used to assess student understanding through synthesis, analysis, and evaluation of broad concepts and issues. Teachers should set up a structure or rubric for grading the essay assignment. Internet sites and electronic information can open up problems when it comes to essays, such as plagiarism. Teachers should precede the essay assignment with an explanation of the school’s policy on plagiarism and the specified consequences. One way to see if students truly researched a topic or simply cut and pasted electronic information is to include a brief essay on the final exam synthesizing the student’s previous essay assignments (Gomez, 2001).

Formal testing: Multiple choice and short-answer tests may be appropriate ways to check understanding of content. Formal testing may be used in conjunction with the above assessment strategies to assess understanding of core concepts and principles.

Student Interviews can be conducted to assess level of understanding and to probe for feasible solutions to design problems. Teachers may develop sample questions in advance of an activity to guide the interviews. Student-generated questions may be used to assess progress.

Seminars and panel discussions provide opportunities for informal assessments in which students share their knowledge and understanding and give everyone else a feel for the progress of the group as a whole. Teachers may formally assess student knowledge and presentation of knowledge using these strategies.

Regardless of the assessment strategies selected, the teacher should use a variety of assessments to ensure that students are learning the specified content in each of the units.

Unit Framework

Each unit is organized according to the following sections to prepare the teacher to successfully implement the unit content:

Overview introduces the technology content for the unit and suggests ways for the teacher to begin the unit instruction.

Enduring results are the content that the students will know and activities they will be able to do. In this guide, the enduring results are selected content standards from *Standards for Technological Literacy: Content for the Study of Technology* (ITEA, 2000). The enduring results specify what students should know and be able to do as it relates to the study of technology.

Acceptable Evidence identifies what students will need to do to demonstrate that they have attained the specified standards. Using more than one assessment approach for a standard provides a more complete picture of each student's knowledge and abilities.

Teacher preparation provides guidance to the teacher for gathering information, consulting with content specialists, and preparing for the suggested instructional activities.

Unit Content is based on the enduring results at the beginning of the unit. The content is presented in outline form and provides a suggested sequence for the unit.

Suggested Learning Activities present activities that teachers can use to support the content in the unit. The teacher may decide to use other instructionally appropriate activities that contribute to the enduring results.

Assessment is key to monitoring student progress and ensuring that students understand the content. This section suggests ways to assess individuals and groups of students.

Resources related to the unit content and activities are given for teacher reference. Resources include books, videos, and websites. Note: Website information may change. Care has been taken to identify stable sites.

In Chapter 2, the following units of instruction will be presented:

Unit 1: Foundations and Characteristics of Technology, will explore the scope of technology, its core concepts, and connections. Students will learn about major technological developments and how they changed over time. In addition, they will investigate how various factors influence innovations.

Unit 2: Effects and Influence of Technology, students will be introduced to the effects and influences of technology. This unit will explore the cultural, social, economic, and political effects of technology, the effects of technology on the environment, and influence of technology on history.

Unit 3: Using Technology, students will be introduced to the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving. Students will also develop the abilities to use and maintain technological products and systems

Unit 4: Assessment of Technologies, will cover ways to assess the impacts of products and systems. Students will develop assessment techniques through the suggested learning activities.

Unit 5: Building Your Dreams, students will be introduced to the attributes of design and what engineering design is, and will be able to apply the design process. Students will design, build, and test prototypes for different technologies.

Each unit will provide suggestions for content, methods, and assessment strategies. Technology teachers can use this information to develop and implement instruction that develops

4. Foundations of Technology: Units of Instruction

Overview

Foundations of Technology is designed as the cornerstone technology education course for the high school. It provides content and experiences that address the nature of technology, technology and society, relationships of technology with other content areas, and design concepts, approaches, and requirements. Different technologies provide exciting contexts and content that connect with the real world of technology. *Foundations of Technology* engages high school students in a broad study of technology and how it affects every aspect of our lives. In this course, students address crucial issues, current and future problems, and exciting opportunities associated with technology. In laboratory-classroom activities they experience ways to create, use, improve, control, and assess technology that contribute to their technological literacy.

Teachers should read and review the model course content and become familiar with all the units in this guide. It will be important to set time aside for advance planning before implementing this course. Perusing the listed websites and books, as well as finding additional resources, will be part of this planning time. The sample activities and academic connections in each unit are linked to the technological literacy standards. Suggested learning activities in this guide may be adapted for your local setting. For example, if you live in a highly agricultural area, the class may focus more on agricultural and biotechnology activities. If medical or communication technologies are prominent in your community, you may want to develop and use classroom activities that use local expertise and resources.